Teenage motherhood: where you live is also important. A prospective cohort study of 14,000 women

Published in:
Health and Place

Document Version:
Peer reviewed version

Queen's University Belfast - Research Portal:
Link to publication record in Queen's University Belfast Research Portal

Teenage motherhood: where you live is also important. A prospective cohort study of 14,000 women

David M Wright[1], Michael Rosato[2], Rachel Doherty[3], Dermot O'Reilly[1]

1. Centre for Public Health, Queen's University Belfast, Belfast, UK

2. *Bamford Centre for Mental Health and Wellbeing, Ulster University, Londonderry, UK*

3. *Public Health Agency, 12-22 Linenhall Street, Belfast, UK*

Corresponding author: David M Wright

+44 2890 978939

d.wright@qub.ac.uk

Centre for Public Health, Institute of Clinical Sciences – Block B, Queen's University Belfast, Royal Victoria Hospital, Grosvenor Road, Belfast, BT12 6BA, UK

16   # Teenage motherhood: where you live is also important. A
17   # prospective cohort study of 14,000 women

18   ## Abstract

19   The United Kingdom has among the highest rates of teenage motherhood (TM) in Western Europe.

20   The relationship to individual social and material disadvantage is well established but the influence

21   of area of residence is unclear. We tested for additional TM risks in deprived areas or in cities. The

22   Northern Ireland Longitudinal Study was used to identify 14,055 nulliparous females (15-18). TM risk

23   was measured using multilevel logistic regression, adjusting for health status, religion, family

24   structure, socio-economic status, rurality and employment-based area deprivation. Most variation in

25   TM was driven by individual, household and socioeconomic factors with the greatest proportion of

26   mothers in low value or social rented accommodation. Living in an area with fewer employment

27   opportunities was associated with elevated TM risk (most vs. least deprived, OR_{adj} = 1.98 [1.49,

28   2.63]), as was urban dwelling (urban vs. intermediate, OR_{adj} = 1.42 [1.13, 1.78]). We conclude that

29   area of residence is a significant independent risk factor for TM. Interventions should be targeted

30   towards the most deprived and urban areas and to those in the lowest value housing.

31   ## Keywords

32   teenage motherhood; urban/rural; area deprivation

33

34

2

Introduction

Early child-bearing may have a profound impact on the well-being of adolescents, being associated with reduced educational attainment and curtailed career prospects (Chevalier et al., 2003; Navarro and Walker, 2012). Births to young teens (13 – 16 years old) have been associated with negative health outcomes for both mothers and children (Reime et al., 2008; Kuo et al., 2010) and children of teenage mothers are at increased risk of emotional and behavioural problems (Moffitt and the E-Risk Study Team, 2002). Social and economic costs associated with supporting these groups may be considerable although there remains debate over whether teenage motherhood should be considered a social problem and whether early reproduction should be discouraged (Duncan, 2007; Bonell, 2004; Lawlor and Shaw, 2002).

The evidence base about individual and household factors associated with teenage motherhood is well established but the influence of area of residence is less clear. At the individual level, low socio-economic status (SES), poor educational attainment and mental health problems have been associated with increased teenage motherhood risk (Kiernan, 1997; Lehti et al., 2012; Horwitz et al., 1991). Women born to young mothers may be more likely to become young mothers themselves (Kahn and Anderson, 1992; Lehti et al., 2012; Horwitz et al., 1991), as are those not living with both parents (Lehti et al., 2012). There have been fewer studies of teenage fatherhood but similar associations with low SES and educational attainment have been found (Kiernan, 1997). Associations between teenage fatherhood and problems at home and school, drug use and early onset of sexual activity have been reported (Dearden et al., 1995; Thornberry et al., 1997) but for teenagers of both sexes, birth of a child can mark a turning point towards more positive behaviours and maturity (Duncan, 2007; Enderstein and Boonzaier, 2015).

Many risk factors for teenage motherhood are shared with teenage pregnancy (Woodward et al., 2001; Imamura et al., 2007; Gibb et al., 2012), however some factors influence only post-conception reproductive decisions and so the strength of the relationship between teenage pregnancy and motherhood rates can vary considerably among populations (Smith, 1993). For example, variation in

3

61   pregnancy outcomes among areas in England may be due to varying policies on abortion provision

62   among health authorities (Diamond et al., 1999).

63   Ecological studies have revealed higher rates of teenage pregnancy in deprived areas (McLeod, 2001;

64   Bradshaw et al., 2005) and risk increasing with distance to family planning clinics in some urban

65   areas (Diamond et al., 1999). Family planning services may influence teenage pregnancy and

66   motherhood rates at the area level; GP practices with female or younger doctors have been

67   associated with lower teenage pregnancy rates (Hippisley-Cox et al., 1999). However, ecological

68   studies cannot distinguish whether variation in risk is due to population composition (the

69   characteristics of residents) or to features of the areas themselves. Rare multilevel studies have

70   found residual regional variation in teenage pregnancy risk after adjusting for household SES and

71   family structure (Finland) (Vikat et al., 2002) and elevated risks of teenage motherhood in some

72   urban areas whilst adjusting for area deprivation, individual and household factors (UK) (McCulloch,

73   2001).

74   In this study, we develop a detailed picture of the risk factors for teenage motherhood, formally

75   testing whether area level deprivation and urban/rural residence are associated with teenage

76   motherhood risk independent of a wide range of individual and household characteristics. Rather

77   than relying on survey responses from a potentially difficult to reach demographic group, we used a

78   large scale linkage of birth records with Census records to investigate gradients of teenage

79   motherhood risk in Northern Ireland (NI).

80   The social context surrounding teenage sexual behaviour and fertility differs between Northern

81   Ireland and Great Britain. In Northern Ireland, abortion is illegal unless it can be proven that the life

82   of the mother is at serious risk and so teenagers may travel to Great Britain to obtain an abortion. In

83   2014, 107 NI resident women under twenty obtained an abortion in England or Wales (Department

84   of Health, 2015). The number of NI residents obtaining an abortion in Scotland is not reported in

4

85   official statistics as these women are frequently assigned a temporary postcode in Scotland for the

86   purposes of treatment (Information Services Division, 2016).

87   Although some denominations are in decline, religious affiliation is an important indicator of social

88   identity and churches retain a stronger influence on social norms especially regarding sexual

89   behaviour than would be observed in Great Britain. There are separate school systems

90   corresponding to the two dominant communities, the Catholic system and the state system that is

91   predominantly attended by Protestants. Catholic schools have traditionally placed a low emphasis

92   on contraception in the sex education curriculum (Rolston et al., 2005), consistent with the strong

93   anti-abortion teaching of the Catholic Church. Opposition to abortion from both the Catholic Church

94   and conservative Protestant denominations is largely responsible for the continued ban on abortion

95   in NI.

96   To account for these features and to gain additional insight into underlying mechanisms we included

97   measures not previously used in studies of teenage motherhood. Current religious affiliation was

98   included as those with no religious affiliation might have lower risk of teenage motherhood due to

99   increased use of contraception and/or use of abortion services compared with those declaring an

100   affiliation. In addition to measures of SES based on parental occupation which reflect current

101   exposure to social environments, we used house value as a measure of accumulated household

102   wealth and indicator of cumulative exposure to these environments. Wealth may indirectly reduce

103   teenage motherhood risk by encouraging teenagers to delay childbearing to pursue education and

104   careers but may also have a direct influence by increasing the ability to travel to Great Britain to

105   obtain an abortion.

106   Rates of teenage motherhood have decreased in the UK over recent years, a trend that partially

107   reflects an increase in the proportion of pregnancies aborted; in England and Wales the proportion

108   of pregnancies aborted among the under 20s increased from 34.7% in 1994 to 44.6% in 2014 (ONS,

109   2016). Despite this decreasing trend the UK has some of the highest rates of teenage motherhood in

110   Western Europe. In 2012, there were 19.7 births per 1000 women aged 15-19 (ONS, 2014). In

111   Northern Ireland alone the rate was slightly lower (18.1 births per 1000, NISRA, 2015).

Methods

Data sources

114   The study cohort was drawn from the Northern Ireland Longitudinal Study (NILS) which comprises

115   data from the Northern Ireland Health Card registration system linked to Census and vital events

116   data from administrative sources (O'Reilly et al., 2012). The representative sample covers

117   approximately 28% of the population, an unprecedentedly large population fraction for a study of

118   teenage motherhood. A cohort of nulliparous women aged 15 to 18 at the 2001 Census was

119   identified. The 15 to 19 age range is widely used for comparisons of teenage motherhood rates over

120   time and between countries (e.g. ONS, 2014; Kiernan, 1997). A focus of this analysis was on the

121   influence of household and family characteristics on teenage motherhood risk and the likelihood of a

122   young woman leaving the family home increases considerably at University entry age. Therefore we

123   excluded those aged 19 at baseline because for women that have left home household

124   characteristics were not available. Also for this reason we excluded 88 women living in communal

125   establishments. The majority (59) were in educational establishments (including halls of residence),

126   14 were in children's homes and the remaining 15 were in hostels, care homes, prison or psychiatric

127   hospitals. We also excluded 184 cases with incomplete information, leaving a final cohort size of

128   14,055. The risk period for each woman comprised the period in which she remained under 20,

129   giving a maximum follow up duration of five years. First births were the primary outcome and at this

130   point women were excluded from the risk set so subsequent births did not contribute to our

131   estimates. Contextual information on the cohort members, drawn from 2001 Census returns was

132   anonymised, held in a secure environment by the Northern Ireland Statistics and Research Agency

133   (NISRA) and made available to the research team for this study. The use of the NILS for research was

134   approved by the Office for Research Ethics Committees Northern Ireland (ORECNI).

6

Individual measures

136 Cohort attributes were selected based on those factors previously associated with variation in

137 teenage motherhood risk or that might plausibly be so. Two measures of self-reported health status

138 were included; general health (good/fair/not good) and whether the respondent had a long term

139 health condition that limited normal activities of daily living. Current religion (Roman

140 Catholic/Church of Ireland/Methodist/No religion or other religion/Other Christian/Presbyterian)

141 was recorded. Only 30 cohort members reported belonging to 'other' religions and so these were

142 grouped with those reporting no religion. Previous analyses have demonstrated that Other

143 Christians are more conservative and the group has healthier behaviours and outcomes (O'Reilly and

144 Rosato, 2010). Whether the cohort member was living with parents was also recorded. Cohort

145 members were grouped into those living with both parents and those who were not, as an

146 exploratory analysis revealed no statistically significant difference in teenage motherhood risk for

147 those living with just one parent and those living with neither parent.

148 *Household factors*

149 Socio-economic status of the household was captured using four variables. Social class of the head of

150 household was based on the National Statistics Socio-Economic Classification (NS-SEC)(Rose and

151 Pevalin, 2002) and was used along with their economic activity (employed/inactive/unemployed).

152 The head of household was identified using a combination of variables. Lone parents were taken to

153 be head of household. In couple families, the partner with the highest level of economic activity was

154 head. If both had the same activity, the elder was selected or if both were the same age, the first

155 entered on the Census form was selected. If household members were unrelated, or there was more

156 than one family present, the same set of rules was used to select the head from among them. Access

157 to cars (none/one/two or more) was used along with a composite measure of housing tenure

158 (owner occupied/privately rented/social rented) and value (house value classified into five

159 categories if owner occupied).

7

Area factors

161 A measure representing potential employment prospects for cohort members based on the

162 proportion of the population involuntarily excluded from the workforce was derived from the

163 Multiple Deprivation Measure (MDM) (NISRA, 2005a). It was calculated for 890 Census Super Output

164 Areas (SOAs, ~2000 people each), which were then classified into quintiles.

165 There is no universally agreed definition of what constitutes an 'urban' or 'rural' area but the official

166 classification in Northern Ireland (NISRA, 2005b) is based on population size, density and access to

167 services. Census Output Areas (~300 people each) are grouped into eight settlement bands ranging

168 in size from settlements of less than 1000 people to the Metropolitan Area of Belfast (c. 580,000

169 people). To ensure an adequate sample size in each group, we re-categorised the bands into three

170 similarly sized groups; urban – comprising the largest two cities; intermediate – combining large,

171 medium, and small towns and intermediate areas; and rural - comprising open country and

172 settlements of less than 1000 people.

Analysis strategy

174 Teenage motherhood risk was estimated using logistic regression. A base model was fitted in which

175 spatial variation in teenage motherhood risk was modelled with a random effect for SOA as the sole

176 predictor. Unadjusted associations between explanatory factors and teenage motherhood were

177 assessed by comparing the fit of the base model with models including the factor as the only other

178 predictor using Akaike's Information Criterion (AIC) and Likelihood Ratio Tests. The model with the

179 minimum AIC from the candidate set is the best fitting and a commonly used rule of thumb is that

180 models with AICs four or more units greater than the minimum have substantially less support from

181 the data (Burnham and Anderson, 2004). Adjusted estimates were obtained using multivariable

182 models including combinations of factors associated with teenage motherhood in the univariable

183 analysis. As the influences of individual and household factors on teenage motherhood risk may vary

184 along urban/rural gradients, two-way interactions with settlement band were also tested (in an

185 exploratory analysis a set of fixed effects models stratified by settlement band was fitted which

8

186   indicated the most plausible interactions to test). As a sensitivity analysis, a fully-adjusted model

187   excluding the car access variable was fitted to test whether its inclusion obscured any urban/rural

188   effects, as car access is known to be greater in rural areas for given levels of deprivation.

189   We conducted a secondary analysis to assess the associations between intergenerational factors

190   (cohort members' mothers' reproductive age and marital status) and risk of teenage motherhood,

191   using the subset of cohort members living with their mothers for which this information was

192   available. A model was fitted including these two factors in addition to those from the best fitting

193   model identified in the primary analysis and estimates were compared between models (the living

194   with both parents variable was excluded from the secondary analysis as this was confounded with

195   mothers' marital status).

196   Models were fitted using the *lme4* package (Bates et al., 2014) within the *R* software environment (R

197   Development Core Team, 2012). Logistic regression was used rather than time to event analysis as

198   implementation of multilevel models was considerably less computationally intensive. Given the

199   relatively short at risk period for each cohort member the two methods are likely to yield similar

200   estimates of associations with teenage motherhood risk; this was confirmed in exploratory analysis

201   by comparing estimates from the best fitting logistic model from the primary analysis with a (fixed

202   effects only) Cox model containing the same factors (available on request).

Results

204   Of the 14,055 cohort members, 902 (6.4%) became mothers during a total of 49,327 person years at

205   risk, translating to an unadjusted rate of 18.3 births per 1000 person years at risk. Table 1 shows the

206   baseline characteristics of those that became mothers and those that did not. A slightly smaller

207   proportion of mothers had good general health than non-mothers but similar proportions in both

208   groups reported long-term limiting illness. Cohort distribution by religious affiliations was similar

209   across groups (Table 1) with the exception of those who classified themselves as 'other Christian' or

210   of no religion; a slightly larger proportion of mothers were of no religion than non-mothers but they

9

211   were half as likely to identify as other Christians. Mothers were substantially less likely to live with

212   both parents or to be from households where the head of household was employed. Mothers were

213   more likely to live in households where the head of household was in a lower status occupation,

214   accommodation was rented (especially social housing) or the household had no car (Table 1). In

215   total, 76% of teenage mothers lived in rented accommodation or housing within the lower two value

216   categories, compared with 45% of non-mothers. Mothers were substantially more likely to live in

217   urban or the most deprived areas than non-mothers (53% of mothers lived in urban areas, compared

218   with 37% of non-mothers; Table 1). All factors were associated with teenage motherhood in

219   unadjusted models and were included in the multivariable models with the exception of long-term

220   limiting illness.

221   *Individual measures*
222   Table 2 shows estimated variation in teenage motherhood risk associated with individual and

223   household level predictors from both unadjusted and the best-fitting adjusted model (A - which also

224   adjusted for area level predictors). For most factors, adjustment reduced the magnitude of

225   associations with teenage motherhood risk. Following adjustment, cohort members who reported

226   no religious affiliation were at 42% increased risk of teenage motherhood compared with Roman

227   Catholics. There were no significant differences in risk between Catholics and those belonging to the

228   major Protestant denominations (Table 2). There was an indication that those identifying themselves

229   as 'other Christian' (primarily conservative Protestants) were at reduced risk relative to the

230   mainstream groups although uncertainty around the estimate rendered the comparison statistically

231   insignificant (Table 2).

232   *Household factors*
233   There was a strong relationship between teenage motherhood and household SES though this varied

234   with the measure used. Unadjusted associations between teenage motherhood risk and economic

235   activity or social class of the head of the household were attenuated following adjustment such that

236   they were no longer statistically significant. The exception was where the head of household was in

237 a professional occupation, in which case risk of teenage motherhood was lower than for the

238 reference group (intermediate occupations). However, cohort members from households with two

239 or more cars remained at 41% decreased risk of teenage motherhood compared with households

240 with no cars.

241 House value and tenure, the novel measure of accumulated wealth, was associated with the largest

242 variation in teenage motherhood risk (adjusted OR range 0.25, 1.14 compared with 1.00, 1.98 for

243 employment based area deprivation). There was a pronounced decrease in teenage motherhood risk

244 with increasing house value; cohort members in households within the highest value category were

245 at 75% less risk than those in the lowest value category. Those in rented accommodation were at

246 similar risk to those in the lower two value categories. However, inclusion of house value did not

247 substantially alter the relationships between teenage motherhood and other household measures of

248 SES or individual level variables. With the exception of the effect for two or more cars, estimated

249 effect sizes from the fully adjusted model all lay within the 95% CIs from a model in which only the

250 conventional measures were included (Table 2, right hand column). This indicates that house value

251 represents a different dimension of SES to existing measures.

252 *Area factors*
253 There was additional variation in teenage motherhood risk associated with area of residence;

254 inclusion of area level factors in adjusted models significantly improved model fit (decrease in AIC

255 comparing model without area level factors, E with fully adjusted model, A, Table 3). There was a

256 strong positive association between employment deprivation and teenage motherhood risk in the

257 fully adjusted model (Table 4) and those in areas where the labour market was weakest were at 98%

258 increased risk of teenage motherhood relative to those in the least deprived areas.

259 Teenage motherhood risk was almost twice as high in urban than rural areas, though there was

260 evidence of an interaction between settlement band and family structure (better fit of model A

261 including interaction term than model B without interaction, Table 3). The proportion of cohort

11

262   members living with both parents decreased from rural to urban areas (85%, 70% and 65% in rural,

263   intermediate and urban areas respectively). For this group there was a gradient of increasing

264   teenage motherhood risk from rural to urban areas in unadjusted models but evidence for an

265   independent association following adjustment for other factors was weaker (Table 4, Figure 1).

266   Those not living with both parents were at increased risk of teenage motherhood relative to those

267   living with both parents in all areas (Figure 1) but the risk differential increased from urban to rural

268   areas (ORs of 1.18, 1.34 and 2.16 in urban, intermediate and rural areas respectively). The highest

269   teenage motherhood risks for those not living with both parents were in rural areas, followed by

270   urban and then intermediate areas (Figure 1).

271   Sensitivity analysis indicated that inclusion of the car access variable did not obscure urban/rural

272   effects. Similar gradients were obtained from models including and excluding the variable (Table 4).

273   In the best-fitting model, the standard deviation of the area (SOA) level random effects was

274   negligible (< 0.001) and so residual variation among SOAs contributes little to variation in teenage

275   motherhood risk compared with other factors.

276   *Intergenerational factors*
277   A total of 12,942 cohort members were living with their mothers of which 804 (6.2%) became

278   mothers themselves. The secondary analysis of this group indicated that mothers' age and marital

279   status were strongly associated with teenage motherhood risk of members in both unadjusted and

280   adjusted models (Table 5). Following adjustment, members whose mothers were young (aged <20 at

281   birth of the cohort member) were more than twice as likely to become teenage mothers as those

282   with older mothers (aged 30 or older). Members with mothers who were separated, divorced or re-

283   married were all at greater risk of teenage motherhood than those with married mothers. There

284   were no significant differences in risk between those with married mothers and those whose

285   mothers were single or widowed. Estimated associations with other factors were of similar

286   magnitude to those obtained from the primary analysis (all estimates from the secondary analysis

287   were within the corresponding 95% confidence intervals – not shown) indicating that these two

288   factors made an independent contribution to risk of teenage motherhood.

Discussion

290   This study demonstrates that area of residence is independently associated with risk of teenage

291   motherhood. This suggests that geographical variation in teenage pregnancy risk found in multiple

292   European area-based studies (Imamura et al., 2007; Diamond et al., 1999; Bradshaw et al., 2005)

293   cannot be attributed solely to the types of people living in these areas. The risk gradient associated

294   with area-level employment deprivation was considerable, of greater magnitude than those

295   associated with standard household-level measures of SES (e.g. car access).

296   Although this study did not set out to explore the ways in which area factors influence teenage

297   motherhood, these findings offer some insights into potential underlying mechanisms. We recognise

298   that the associations reported are a conflation of the three main stages leading to teenage

299   motherhood (sexual activity, contraception and abortion). A possible mechanism by which area

300   deprivation may incur additional teenage motherhood risk is through the establishment of early

301   reproductive onset as a social norm (Arai, 2007). This may occur in response to poor labour market

302   and career prospects, as under these conditions postponing family formation to invest time in

303   education and career establishment may have little perceived value. However, the area measure of

304   employment disadvantage was closely correlated with the equivalent measures of income and

305   education deprivation and high teenage motherhood rates may reflect fertility decisions in reaction

306   to shorter healthy life expectancies in deprived areas (Nettle, 2011). Social norms may also explain

307   the lower levels of contraceptive usage found in the most deprived areas of Great Britain (Bentley et

308   al., 2009), although the latter may instead be an indicator of more risky behaviour especially with

309   relation to alcohol (Holmberg and Berg-Kelly, 2002). Our finding that cohort members with young

310   mothers were more likely to become teenage mothers themselves is consistent with other studies

311   (Kahn and Anderson, 1992; Lehti et al., 2012; Horwitz et al., 1991) and so intergenerational

13

312   repetition of fertility behaviours within families is a likely mechanism by which a norm could become

313   established in an area.

314   Risk of teenage motherhood increased along the rural-urban gradient; more than half of teenage

315   mothers were from urban areas, despite the fact that only 38% of the cohort lived in these areas.

316   Consistent with studies of teenage pregnancy (Vikat et al., 2002; McLeod, 2001), this gradient was

317   attenuated following adjustment for household and employment-based area deprivation,

318   highlighting the importance of considering factors operating at multiple scales. It is unlikely that

319   urban/rural variation in teenage motherhood risk was due to distance to family planning services

320   (see McLeod, 2001; Diamond et al., 1999; Bradshaw et al., 2005) as these are clustered in urban

321   areas. Urban areas carried a considerably greater teenage motherhood risk than expected based on

322   deprivation levels and it is possible that teenage motherhood is more closely associated with

323   teenagers' perceptions of the residential environment and future prospects than measured

324   deprivation (Johns, 2011), though the opportunities arising from the greater concentration of

325   teenagers may also play a role. Negative perceptions of life prospects have been associated with

326   other adolescent risk behaviours (e.g. substance use) in Northern Ireland (McKay et al., 2013) and

327   may be more entrenched in deprived urban than rural areas, perhaps due to spatial aggregation of

328   deprivation. Care should be taken before applying these findings to other populations. Studies in

329   multiple countries have compared levels of adolescent risk behaviours along urban-rural gradients

330   (Levine and Coupey, 2003; Forsyth and Barnard, 1999; Chan et al., 2016) but there is no general

331   consensus as to whether those in urban areas adopt these behaviours at a younger age and 'grow up

332   faster' than their rural counterparts. This is likely to be at least partially due to the lack of a universal

333   definition of urban and rural areas; estimates of adolescent smoking and drinking risk in the same

334   population have been shown to vary considerably depending on the definition chosen (Brady and

335   Weitzman, 2007).

14

336 Consistent with European studies (Vikat et al., 2002; Woodward et al., 2001), we found variation in

337 teenage motherhood risk at the household level but the greatest variation was associated with a

338 novel measure of accumulated wealth (housing value and tenure). Those in low value

339 accommodation were at substantially increased risk and 40% of teenage mothers were in social

340 rented housing. At the operational level, wealth may facilitate the procurement of abortion but

341 these findings again highlight that teenage motherhood as a norm may be most established in areas

342 with the highest concentrations of social housing. This hypothesis might be investigated in future by

343 fine-scale classification of areas based on proportion of social housing.

344 In contrast with other studies (e.g. Vikat et al., 2002), we found no graded association between

345 socio-economic class of the head of household and teenage motherhood risk, although those from

346 professional/managerial households were at lower risk in all models. This may indicate that property

347 value as a measure of accumulated wealth better reflects cumulative exposure to social

348 environments conducive to teenage motherhood than current household social position. Therefore

349 we suggest that this measure should be used alongside occupation-based classifications of SES in risk

350 factor studies to gauge the relative influence of past and present SES.

351 We found that religious affiliation was associated with reduced teenage motherhood risk, indicating

352 that personal beliefs and social structures appear to maintain a regulatory influence on sexual

353 behaviour among teenagers within the major Christian denominations. Contrary to expectation,

354 there was no difference in teenage motherhood risk between Roman Catholics and mainstream

355 Protestant groups despite differences in provision of sex education (Rolston et al., 2005; McLaughlin

356 et al., 2007), suggesting that the previously more conservative, marriage focused curriculum in

357 Catholic schools does not substantially reduce overall risk of teenage motherhood. Whilst Roman

358 Catholics are less likely than Protestants to have sex before the age of 16 (Rolston et al., 2004;

359 Schubotz et al., 2004), this may be offset by higher levels of sexual activity as older teens, along with

360 similar levels of contraception use in both groups (McLaughlin et al., 2007).

15

361   Our study had limitations. We were unable to investigate the influence of education on teenage

362   motherhood because cohort members were at varying educational stages on Census day. Also,

363   records were only available for births within Northern Ireland, excluding those who might have

364   emigrated or travelled to Great Britain or the Republic of Ireland to give birth, potentially leading to

365   underestimation of overall teenage motherhood risk. Any bias is likely to be small because the NI

366   population has relatively low rates of migration (Shuttleworth et al., 2013) and there are few

367   compelling reasons why residents should choose to travel to give birth. However, there may be

368   variation among social groups in propensity to travel (especially to Great Britain) to obtain abortions,

369   which are illegal in Ireland (both NI and the Republic, although there are specific exceptions when

370   the mother's life is at serious risk). Both the costs and the concept of travel beyond the immediate

371   locality are likely to act as significant barriers for those in the most deprived groups, potentially

372   contributing towards the elevated teenage motherhood risks for those with low household wealth. A

373   further drawback is that we were unable to determine at which of the stages (sexual behaviour and

374   contraception; propensity for abortion) a factor has the greatest influence on teenage motherhood

375   risk. Parallel analyses of risk factors for teenage pregnancy and teenage motherhood might further

376   disentangle these mechanisms and it is hoped that birth and pregnancy records for this population

377   will be available in future.

378   We used multilevel models to estimate the strength of associations between teenage motherhood

379   and factors operating at the individual, household and area levels. Our study had limitations

380   common to others in which Census tracts are used to measure area effects on health; tracts may not

381   cohere with actual boundaries of neighbourhoods or communities and derived measures such as the

382   MDM may not adequately represent underlying area factors that influence health (Riva et al., 2006).

383   Care must be taken when interpreting multilevel models as they may not accurately represent the

384   relative causal influences of each level (Diez-Roux, 2007). For instance, residence in a particular area

385   for an extended time may alter the characteristics of its inhabitants and so variation associated with

386   area may be underestimated (and individual level variation overestimated) using multilevel models.

16

387 Conversely, inhabitants may be selected into areas based on individual characteristics that are also

388 related to the outcome of interest (Diez Roux, 2004). In our study the greatest potential for overlap

389 is between the household and area levels with households with only one parent or in social housing

390 more likely to be selected towards the poorest areas. A related issue is that house values are likely

391 to be influenced by area deprivation and so are intermediate on the hypothesised pathway from

392 area deprivation to teenage motherhood risk. Inclusion of both factors within the same model may

393 therefore have introduced a degree of statistical over-adjustment, with underestimation of the

394 association between area deprivation and teenage motherhood risk the most likely outcome. The

395 true magnitude of the association is likely to be intermediate between the unadjusted and fully

396 adjusted (model A) estimates. The fact that we found strong area level effects despite these

397 limitations (which are each likely to have diluted area effects) underlines the importance of area in

398 explaining teenage motherhood. Despite these limitations, our estimate of the overall teenage

399 motherhood rate (18.2 births per 1000 person years) was relatively close to official estimates for

400 Northern Ireland, indicating that our cohort was broadly representative of the population, where

401 fertility rates in the 15-19 age group declined during the study period from 23.9 in 2001 to 21.5 in

402 2005 (NISRA, 2015). Our lower estimate may be partially due to exclusion of second births and those

403 living in communal institutions. The upper age limit for cohort members of 18 at Census is also likely

404 to have reduced our estimate because 19 year olds are at the highest risk in the age range. Non-

405 enumeration in the Census may have contributed to the lower estimate but the influence of

406 response bias is likely to be minor compared with survey-based studies (approximately 95% of the

407 population were enumerated).

408 In the largest individual-level study in the UK we have shown that risk of teenage motherhood varies

409 with area of residence independently of a comprehensive range of individual and household

410 characteristics. Those living in urban or more deprived areas were at increased risk of teenage

411 motherhood but household factors (particularly wealth) were associated with the greatest variation

412 in risk. Therefore, policies aiming to reduce teenage motherhood rates may be most effective if

17

413   targeted at deprived areas, in which the majority of teenage mothers live, and towards those living

414   in rented or low value housing. As employment-based area deprivation and low value housing is

415   often concentrated in cities, efforts to reduce teenage motherhood rates in urban areas may bring

416   the greatest benefits.

Acknowledgements

References

426   Arai, L., 2007. Peer and neighbourhood influences on teenage pregnancy and fertility: Qualitative

427   findings from research in English communities. Health & place 13, 87-98.

428   Bates, D., Maechler, M., Bolker, B., Walker, S., 2014. lme4: Linear mixed-effects models using Eigen

429   and S4. Arxiv e-print, 1406.5823.

430   Bentley, R., Kavanagh, A., Smith, A., 2009. Area disadvantage, socioeconomic position and women's

431   contraception use: a multilevel study in the UK. Journal of Family Planning and Reproductive Health

432   Care 35, 221-226.

433   Bonell, C., 2004. Why is teenage pregnancy conceptualized as a social problem? A review of

434   quantitative research from the USA and UK. Culture, Health & Sexuality 6, 255-272.

18

435   Bradshaw, J., Finch, N., Miles, J.N.V., 2005. Deprivation and variations in teenage conceptions and

436   abortions in England. Journal of Family Planning and Reproductive Health Care 31, 15-19.

437   Brady, J.E., Weitzman, B.C., 2007. Inconsistencies in place definition: How different operational place

438   definitions affect estimates of adolescent smoking and drinking risk. Health & place 13, 562-568.

439   Burnham, K.P., Anderson, D.R., 2004. Multimodel Inference: Understanding AIC and BIC in Model

440   Selection. Sociological Methods & Research 33, 261-304.

441   Chan, G.C.K., Leung, J., Quinn, C., Kelly, A.B., Connor, J.P., Weier, M., Hall, W.D., 2016. Rural and

442   Urban Differences in Adolescent Alcohol Use, Alcohol Supply, and Parental Drinking. The Journal of

443   Rural Health 32, 280-286.

444   Chevalier, A., Viitanen, T.K., Viitanen, T.K., 2003. The long-run labour market consequences of

445   teenage motherhood in Britain. Journal of Population Economics 16, 323-343.

446   Dearden, K.A., Hale, C.B., Woolley, T., 1995. The antecedents of teen fatherhood: a retrospective

447   case-control study of Great Britain youth. Am J Public Health 85, 551-554.

448   Department of Health. 2015Abortion statistics, England and Wales:

449   2014https://www.gov.uk/government/collections/abortion-statistics-for-england-and-wales.

450   Diamond, I., Clements, S., Stone, N., Ingham, R., 1999. Spatial variation in teenage conceptions in

451   south and west England. Journal of the Royal Statistical Society: Series A (Statistics in Society) 162,

452   273-289.

453   Diez Roux, A.V., 2004. Estimating neighborhood health effects: the challenges of causal inference in

454   a complex world. Social science & medicine 58, 1953-1960.

19

455   Diez-Roux, A., 2007. Neighborhoods and health: where are we and were do we go from here? Revue

456   d'epidemiologie et de sante publique 55, 13-21.

457   Duncan, S., 2007. What's the problem with teenage parents? And what's the problem with policy?

458   Critical Social Policy 27, 307-334.

459   Enderstein, A.M., Boonzaier, F., 2015. Narratives of young South African fathers: redefining

460   masculinity through fatherhood. Journal of Gender Studies 24, 512-527.

461   Forsyth, A.J.M., Barnard, M., 1999. Contrasting levels of adolescent drug use between adjacent

462   urban and rural communities in Scotland. Addiction 94, 1707-1718.

463   Gibb, S.J., Fergusson, D.M., Horwood, L.J., 2012. Childhood family income and life outcomes in

464   adulthood: Findings from a 30-year longitudinal study in New Zealand. Social science & medicine 74,

465   1979-1986.

466   Hippisley-Cox, J., Allen, J., Pringle, M., Ebdon, D., McPhearson, M., Churchill, D., Bradley, S., 1999.

467   Association between teenage pregnancy rates and the age and sex of general practitioners: cross

468   sectional survey in Trent 1994-7. BMJ : British Medical Journal 320, 842-845.

469   Holmberg, L., Berg-Kelly, K., 2002. Health, health-compromising behaviour, sexuality and

470   involvement in pregnancy among 18-year-old Swedish males: a cross-sectional survey. Acta

471   Pædiatrica 91, 838-843.

472   Horwitz, S.M., Klerman, L.V., Kuo, H.S., Jekel, J.F., 1991. Intergenerational transmission of school-age

473   parenthood. Family planning perspectives 23, 168-177.

474   Imamura, M., Tucker, J., Hannaford, P., da Silva, M.O., Astin, M., Wyness, L., Bloemenkamp, K.W.M.,

475   Jahn, A., Karro, H., Olsen, J., Temmerman, M., 2007. Factors associated with teenage pregnancy in

20

476   the European Union countries: a systematic review. The European Journal of Public Health 17, 630-

477   636.

478   Information Services Division. 2016Termination of pregnancy statistics - year ending December

479   2015.http://www.isdscotland.org/Health-Topics/Sexual-Health/Abortions/.

480   Johns, S.E., 2011. Perceived environmental risk as a predictor of teenage motherhood in a British

481   population. Health & place 17, 122-131.

482   Kahn, J.R., Anderson, K.E., 1992. Intergenerational patterns of teenage fertility. Demography 29, 39-

483   57.

484   Kiernan, K.E., 1997. Becoming a Young Parent: A Longitudinal Study of Associated Factors. The British

485   journal of sociology 48, 406-428.

486   Kuo, C., Lee, S., Wu, W., Liao, W., Lin, S., Lee, M., 2010. Birth outcomes and risk factors in adolescent

487   pregnancies: Results of a Taiwanese national survey. Pediatrics International 52, 447-452.

488   Lawlor, D.A., Shaw, M., 2002. Too much too young? Teenage pregnancy is not a public health

489   problem. International journal of epidemiology 31, 552-553.

490   Lehti, V., Niemelä, S., Heinze, M., Sillanmäki, L., Helenius, H., Piha, J., Kumpulainen, K., Tamminen, T.,

491   Almqvist, F., Sourander, A., 2012. Childhood predictors of becoming a teenage mother among

492   Finnish girls. Acta Obstetricia et Gynecologica Scandinavica 91, 1319-1325.

493   Levine, S.B., Coupey, S.M., 2003. Adolescent substance use, sexual behavior, and metropolitan

494   status: is "urban" a risk factor? Journal of Adolescent Health 32, 350-355.

495   McCulloch, A., 2001. Teenage childbearing in Great Britain and the spatial concentration of poverty

496   households. Journal of epidemiology and community health 55, 16-23.

21

497   McKay, M.T., Percy, A., Cole, J.C., 2013. Present orientation, future orientation and alcohol use in

498   Northern Irish adolescents. Addiction Research & Theory 21, 43-51.

499   McLaughlin, M., Thompson, K., Parahoo, K., Armstrong, J., Hume, A., 2007. Inequalities in the

500   provision of sexual health information for young people. Journal of Family Planning and

501   Reproductive Health Care 33, 99-105.

502   McLeod, A., 2001. Changing patterns of teenage pregnancy: population based study of small areas.

503   BMJ 323, 199-203.

504   Moffitt, T.E., the E-Risk Study Team, 2002. Teen-aged mothers in contemporary Britain. Journal of

505   Child Psychology and Psychiatry 43, 727-742.

506   Navarro, M., Walker, I., 2012. The Impact of Teenage Motherhood on the Education and Fertility of

507   Their Children: Evidence for Europe. IZA Discussion Paper No. 6995.

508   Nettle, D., 2011. Flexibility in reproductive timing in human females: integrating ultimate and

509   proximate explanations. Philosophical Transactions of the Royal Society B: Biological Sciences 366,

510   357-365.

511   NISRA. 2015 Age-specific fertility rates, Northern Ireland 2001-2013 [online].

512   Available:http://www.nisra.gov.uk/demography/default.asp23.htm.

513   NISRA. 2005aNorthern Ireland Multiple Deprivation Measure 2005The Stationary OfficeNorwich, UK.

514   NISRA. 2005bReport of the inter-deparmental urban-rural definition group: statistical classification

515   and delineation of settlements.Northern Ireland Statistics and Research AgencyBelfast.

516   O'Reilly, D., Rosato, M., 2010. Dissonances in self-reported health and mortality across

517   denominational groups in Northern Ireland. Social science & medicine 71, 1011-1017.

518 O'Reilly, D., Rosato, M., Catney, G., Johnston, F., Brolly, M., 2012. Cohort description: The Northern

519 Ireland Longitudinal Study (NILS). International journal of epidemiology 41, 634-641.

520 ONS. 2016 Conceptions in England and Wales:2014 [online].

521 Available:http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/conc

522 eptionandfertilityrates/bulletins/conceptionstatistics/2014;.

523 ONS. 2014 International comparisons of teenage births [online].

524 Available:http://www.ons.gov.uk/ons/rel/vsob1/births-by-area-of-usual-residence-of-mother--

525 england-and-wales/2012/sty-international-comparisons-of-teenage-pregnancy.html.

526 R Development Core Team, 2012. R: A Language and Environment for Statistical Computing. R

527 Foundation for Statistical Computing, Vienna, Austria.

528 Reime, B., Schucking, B., Wenzlaff, P., 2008. Reproductive outcomes in adolescents who had a

529 previous birth or an induced abortion compared to adolescents' first pregnancies. BMC Pregnancy

530 and Childbirth 8, 4.

531 Riva, M., Gauvin, L., Barnett, T.A., 2006. Toward the next generation of research into small area

532 effects on health: a synthesis of multilevel investigations published since July 1998. Journal of

533 epidemiology and community health 61, 853-861.

534 Rolston, B., Schubotz, D., Simpson, A., 2004. The first time: young people and sex in Northern

535 Ireland. Journal of Youth Studies 7, 191-207.

536 Rolston, B., Schubotz, D., Simpson, A., 2005. Sex education in Northern Ireland schools: a critical

537 evaluation. Sex Education 5, 217-234.

538 Rose, D., Pevalin, D., 2002. A Researcher's Guide to the National Statistics Socio- Economic

539 Classification. Sage, London.

540   Schubotz, D., Rolston, B., Simpson, A., 2004. Sexual behaviour of young people in Northern Ireland:

541   first sexual experience. Critical Public Health 14, 177-190.

542   Shuttleworth, I., Barr, P.J., Gould, M., 2013. Does Internal Migration in Northern Ireland Increase

543   Religious and Social Segregation? Perspectives from the Northern Ireland Longitudinal Study (NILS)

544   2001-2007. Population, Space and Place 19, 72-86.

545   Smith, T., 1993. Influence of socioeconomic factors on attaining targets for reducing teenage

546   pregnancies. BMJ : British Medical Journal 306, 1232-1235.

547   Thornberry, T.P., Smith, C.A., Howard, G.J., 1997. Risk Factors for Teenage Fatherhood. Journal of

548   Marriage and Family 59, 505-522.

549   Vikat, A., Rimpelä, A., Kosunen, E., Rimpelä, M., 2002. Sociodemographic differences in the

550   occurrence of teenage pregnancies in Finland in 1987–1998: a follow up study. Journal of

551   epidemiology and community health 56, 659-668.

552   Woodward, L., Fergusson, D.M., Horwood, L.J., 2001. Risk Factors and Life Processes Associated with

553   Teenage Pregnancy: Results of a Prospective Study From Birth to 20 Years. Journal of Marriage and

554   Family 63, 1170-1184.

555

Tables

557 Table 1. Baseline characteristics of 15-18 year old nulliparous females in Northern Ireland, 2001 by teenage
558 motherhood status.

	Non-mothers (%)	Teenage mothers (%)
Cohort (N)	13153	902
Individual		
General health		
Good	89.2	85.0
Fair	9.0	13.0
Not good	1.8	2.0
Long term limiting illness		
Yes	5.1	6.2
No	94.9	93.8
Religion		
Roman Catholic	47.5	49.9
Church of Ireland	13.2	13.9
Methodist	3.2	3.3
No religion	11.2	15.6
Other Christian	5.8	2.7
Presbyterian	19.0	14.6
Living with both parents		
Yes	74.1	50.4
No	25.9	49.6
(Head of) household		
Economic activity		
Employed	76.7	55.3
Unemployed	3.8	7.8
Inactive/Student	19.5	36.9
Social class (NS-SEC)		
Professional/Managerial	28.9	14.7
Intermediate/Small employers/Self employed	25.0	18.4
Lower supervisory/routine	39.5	51.9
Long term unemployed/full-time student	6.5	15.0
Housing tenure		
Owner occupied: more than £200,000	11.8	2.1
Owner occupied: £150,000-£199,999	14.1	5.4
Owner occupied: £100,000-£149,999	23.3	14.1
Owner occupied: £75,000-£99,999	13.2	14.5
Owner occupied: less than £75,000	9.2	12.3
Owner occupied: value unknown	5.6	2.3
Privately rented	5.0	8.9
Social rented	17.8	40.4
Car access		
None	14.3	36.8
One	39.5	43.1
Two+	46.1	20.1
Area		
Settlement band		
Rural	30.3	15.7
Intermediate	32.8	31.6
Urban	36.8	52.7
Employment deprivation (quintile)		
(least deprived) 1	19.9	8.6
2	20.2	12.4

	3	20.6	16.4
	4	20.4	21.0
(most deprived) 5		18.9	41.6

559

560

Table 2. Association between risk of teenage motherhood and individual and household explanatory factors in Northern Ireland, 2001-2005 (N=14,055). Only individual and household variables presented to the multivariable models are included in the table (i.e. long term limiting illness excluded). Models are also adjusted for employment-based area deprivation and rurality.

	Unadjusted		Fully adjusted (model A)		Fully adjusted minus house value (model D)	
	OR	95% CI	OR	95% CI	OR	95% CI
Individual						
General health						
Good	0.69	(0.56, 0.85)	0.90	(0.73,1.11)	0.88	(0.71,1.08)
Fair	1.00		1.00		1.00	
Not good	0.72	(0.42,1.24)	0.72	(0.42,1.21)	0.70	(0.41,1.19)
Religion						
Roman Catholic	1.00		1.00		1.00	
Church of Ireland	1.03	(0.82,1.29)	1.17	(0.94,1.46)	1.26	(1.02,1.56)
Methodist	0.98	(0.65,1.49)	1.23	(0.82,1.83)	1.32	(0.88,1.96)
No religion	1.36	(1.09,1.68)	1.42	(1.15,1.76)	1.50	(1.22,1.86)
Other Christian	0.45	(0.29,0.70)	0.66	(0.43,1.02)	0.72	(0.47,1.11)
Presbyterian	0.77	(0.61,0.96)	1.06	(0.86,1.31)	1.12	(0.90,1.38)
Living with both parents						
Yes	1.00		1.00		1.00	
No	2.61	(2.26,3.01)	1.34	(1.03,1.75)	1.42	(1.09,1.84)
(Head of) household						
Economic activity						
Employed	1.00		1.00		1.00	
Unemployed	2.65	(2.01,3.51)	1.30	(0.93,1.82)	1.39	(1.00,1.94)
Inactive/Student	2.43	(2.09,2.84)	1.13	(0.94,1.37)	1.22	(1.02,1.46)
Social class (NS-SEC)						
Professional/Managerial	0.68	(0.54,0.87)	0.79	(0.62,1.00)	0.73	(0.57,0.92)
Intermediate/Small employers/Self employed	1.00		1.00		1.00	
Lower supervisory/routine	1.66	(1.37,2.01)	0.95	(0.78,1.16)	1.04	(0.86,1.27)
Long term unemployed/full-time student	2.75	(2.14,3.54)	0.98	(0.73,1.32)	1.07	(0.80,1.44)
Housing tenure						
Owner occupied: more than £200,000	0.13	(0.08,0.22)	0.25	(0.15,0.43)		
Owner occupied: £150,000-£199,999	0.29	(0.20,0.41)	0.50	(0.34,0.72)		
Owner occupied: £100,000-£149,999	0.46	(0.35,0.60)	0.65	(0.49,0.85)		
Owner occupied: £75,000-£99,999	0.83	(0.63,1.08)	0.91	(0.69,1.19)		
Owner occupied: less than £75,000	1.00		1.00			
Owner occupied: value unknown	0.32	(0.19,0.52)	0.53	(0.32,0.87)		
Privately rented	1.33	(0.98,1.82)	1.14	(0.82,1.57)		
Social rented	1.66	(1.32,2.09)	1.08	(0.84,1.38)		
Car access						
None	1.00		1.00		1.00	
One	0.44	(0.37,0.51)	0.76	(0.63,0.92)	0.70	(0.58,0.84)
Two+	0.18	(0.15,0.22)	0.59	(0.45,0.76)	0.45	(0.35,0.58)

565

566 Table 3 – Comparison of multivariable models of risk of teenage motherhood in Northern Ireland,
567 2001 – 2005. Model fit assessed using Akaike's Information Criterion (AIC). Models in order of
568 decreasing fit. A difference in AIC of four or greater indicates a substantial difference in explanatory
569 power between two models.

Model	Details	AIC	df
A	Fully adjusted	6158	32
B	Fully adjusted minus interaction	6162	30
C	Fully adjusted minus car access	6171	30
D	Fully adjusted minus house value	6197	25
E	Fully adjusted minus area factors	6203	24

570
571

572 Table 4. Association between risk of teenage motherhood and area explanatory factors in Northern Ireland,

573 2001-2005 (N=14,055). Only variables presented to the multivariable model are included in the table. Variables

574 excluded from the final multivariable model: long term limiting illness. Fully adjusted model: general health,

575 religion, living with both parents, economic activity, social class, housing tenure, car access.

	Unadjusted model		Fully adjusted (model A)		Fully adjusted minus car access (model C)	
	OR	95% CI	OR	95% CI	OR	95% CI
Area						
Settlement band						
Rural	0.55	(0.44,0.69)	0.81	(0.61,1.07)	0.76	(0.58,1.01)
Intermediate	1.00		1.00		1.00	
Urban	1.47	(1.23,1.77)	1.42	(1.13,1.78)	1.45	(1.16,1.82)
Employment deprivation (quintile)						
(least deprived) 1	1.00		1.00		1.00	
2	1.40	(1.02,1.92)	1.17	(0.86,1.59)	1.15	(0.84,1.56)
3	1.94	(1.48,2.56)	1.38	(1.04,1.82)	1.34	(1.01,1.77)
4	2.69	(2.01,3.60)	1.52	(1.13,2.05)	1.47	(1.09,1.98)
(most deprived) 5	4.97	(3.84,6.42)	1.98	(1.49,2.63)	1.88	(1.41,2.50)

576

577

578　Table 5. Association between risk of teenage motherhood for cohort members by age and marital status of
579　members' mothers, Northern Ireland, 2001-2005. Only cohort members living with mothers were included
580　(N=12,942). Fully adjusted model: general health, religion, economic activity, social class, housing tenure, car
581　access, settlement band, employment deprivation.

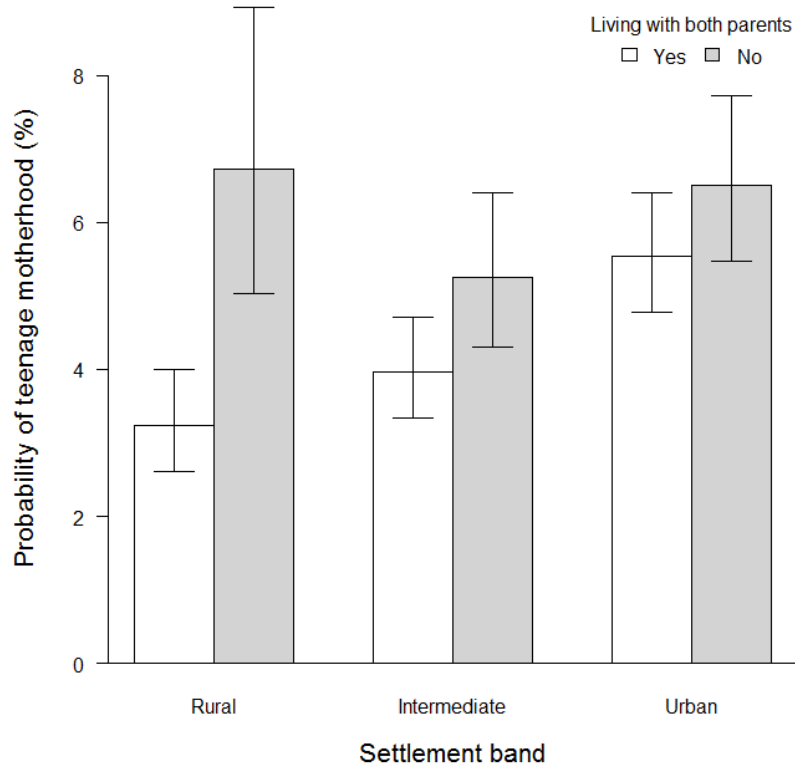|	Unadjusted model		Fully adjusted	
	OR	95% CI	OR	95% CI
Mothers age (at birth of cohort member)				
<20	3.79	(2.86,5.03)	2.23	(1.68,2.97)
20-29	1.83	(1.52,2.20)	1.52	(1.27,1.83)
≥30	1.00		1.00	
Mothers marital status				
Single	3.33	(2.33,4.76)	1.15	(0.79,1.67)
Married	1.00		1.00	
Separated	3.26	(2.67,3.99)	1.43	(1.15,1.80)
Divorced	3.35	(2.70,4.17)	1.63	(1.29,2.06)
Re-married	2.34	(1.67,3.28)	1.80	(1.29,2.53)
Widowed	1.91	(1.21,3.02)	1.37	(0.86,2.17)

582

30

Figures

584   Figure 1. Predicted probability (%) of teenage motherhood by rurality and family structure.

585   Predictions from fully adjusted model (A) with all other variables at mean values.

586

587

31